SCIENCE:

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NOTICE TO SUBSCRIBERS.

We consider it due to those subscribers who have favored us with their subscriptions, previous to the publication of our club rates, that they should have the privileges of the list. They can therefore send us subscriptions for any of the publications named at the reduced double rates, less $4, the subscription price of "SCIENCE."

Since the publication of the club rates last week, we have received rates from the proprietor of *The American Journal of Science and Arts*, the terms of which are $6 a year. The club rate with SCIENCE will be $8.50 per annum.

EARNEST advocates of a higher order of education now regard with satisfaction the prospect of the establishment of a State University in Texas upon a sound, financial basis.

As early as 1839 public land amounting to fifty leagues were dedicated to found a university for this State, and when commissioners were appointed to locate the city of Austin, forty acres were reserved, and forever devoted as a site for the University of Texas.

For twenty years the matter remained in abeyance, but in 1858 an attempt at organization was made, the Legislature passing an act for the immediate establishment of the University, and one hundred thousand dollars were appropriated from the State Treasury for the purpose. The approach of the civil war led to a second postponement, and a third attempt in 1866 was equally unsuccessful.

The present prospects for the future of the University of Texas are very encouraging to those who desire its early establishment and successful organization. Professor Oscar H. Cooper, in an article in the *International Review*, gives the following information on the subject, which will be read with interest:

He states that the constitution adopted in 1876 supersedes all previous legislation and is the organic law of the State. Its provisions concerning the University are wise and generous. It directs the Legislature to inaugurate the institution as soon as practicable, secures to the funds all previous appropriations, directs that only the interest on the funds shall be used, and adds to already growing resources one million acres of the public domain—a territory considerably larger than Rhode Island. It prescribes the object of the University to be "the promotion of literature and the arts and sciences," and incorporates as a branch of the University, for instruction in agriculture, the mechanic arts and sciences connected therewith, the State Agricultural and Mechanical College, already in 1871 under the federal appropriation for such institutions.

It requires that the location of the University shall be determined by a vote of the people of the whole State, and directs that a College or branch University be established and maintained for the instruction of the colored youths of the State.

Thus the policy of past legislation has been sacredly to guard and freely to augment the resources of the University until they became ample for founding an institution worthy of the name. About half of the land donation to the University has been sold for about $500,000, and the proceeds have been either invested in five, six, or seven per cent. State bonds, or held in ten per cent. land notes.

The sum of $100,000, appropriated to the University in 1858 was borrowed by the State, and in 1866 was replaced by five per cent. State bonds. The invested funds therefore amount to nearly $600,000, and by the sale of lands are steadily increasing. The accrued interest will, at the end of the present year, amount to more than $200,000, and the annual interest on the invested capital exceeds $40,000. The unsold lands are worth at present $1,500,000. The endowment funds, buildings, grounds, etc., of the department of Agriculture and the mechanic arts are valued at $400,000. The University of Texas is worth, therefore, exclusive of $200,000 accrued interest, $2,500,000, and this superb endowment is enhancing in value with the growth of the State in wealth and population. Few even of the most famous institutions of the world began their career on so generous a foundation, and neither Harvard nor Yale was so wealthy at the completion even of their first century.

The people of Texas are said to be now showing a keen interest in the question of education, and, no longer contented with these magnificent provisions for the future, demand the immediate execution of the scheme, the Governor no doubt expressing the popular wish, when he stated "I am opposed to waiting longer."

The probability that the University of Texas will be almost immediately organized has already called for

expression of opinions from those who are anxious for it to fulfill the best hopes of its promoters, and Professor Cooper leads the van of those who, with hopes and fears, already see danger ahead, and would be in time with their council.

The advice of Professor Cooper is most excellent, but in part it appears to us somewhat superfluous; that "the first President of the University of Texas should be pre-eminently an organizer, conversant with the best systems both in America and Europe, and alive to the growing demands of the age, and that the instructors should be the best men, sought without regard to section or creed," are recommendations which involve principles universally acknowledged; if the appointments are not made to accord with these principles, it will not be from ignorance that such a course should be followed.

But alas, academical appointments, like those in political life, are often influenced by "interest" and at some times by "expediency." As an instance of the latter class, we may refer to a case in which a most eminent American Naturalist was a candidate for the chair of Natural History in a Northern University. His high claims over other candidates for the position were admitted, and he was told informally that he had been appointed. The professor was preparing for his new home, when he received the very sudden announcement that another of the candidates had been finally selected for the position. The explanation of the mystery was very simple. The University, or College, was supposed to be filling the chair of Natural History, as Professor Cooper would desire, "with the best man without regard to creed or section," but unfortunately there was a want at the establishment for a man to do ministerial duties; the result was that the trustees, in filling the chair of Natural History, rejected the eminent Naturalist, and selected from among the candidates the one who had the greatest capacity for prayer.

For our part, we believe that such complications suggested by Professor Cooper, are not to be anticipated; when the buildings are ready, the right men to fill the positions in the faculty will be forthcoming. The establishment of a University in America, is no new experiment, and the experience of the past will be a valuable aid to those who will organize the University in Texas.

As a rule, the management of the Universities and Colleges in the United States, is one of the redeeming points which has done much to restore confidence in the institutions of this country; the selection of Professors is also usually judicious, and among the corps of instructors, the number of those who do honor to the position they occupy is fortunately great, and no American now has need to leave his native shores to obtain a thorough knowledge in any department of science.

TYCHO BRAHE'S NEW STAR.

On November 11th, 1572, Tycho Brahe noticed a new and very bright star in the constellation Cassiopeia. Afterwards it appeared that this star had been seen before at various places in Europe, and Tycho, in order to fix its position, and to determine whether it moved, began a series of measures with his sextant, by which he connected the position of the new star with nine known stars in the same constellation. The new star shone with a wonderful brightness, being brighter than the planet Jupiter, and, according to some reports, it was visible in full daylight. In January, 1573, its brightness began to wane, and in May of the same year it was only of the second magnitude, or as bright as Polaris. It remained visible to the naked eye, however, until March, 1574.

This star was also remarkable for the changes of color that it exhibited. At first it was white, then it became yellow, and, finally, red. But in May, 1573, it was again of a dull white color, and remained so until it disappeared.

Although many cases have occurred of new stars blazing out for a short time, and then fading away beyond the sight of the naked eye, such as those of 1866 and 1876, yet Tycho's star, on account of its brilliancy and its long duration, is the most remarkable of any star of this kind of which we have any authentic record; and his observations of it have been carefully reduced and discussed by several astronomers. Professor D'Arrest, of Copenhagen, made a very complete catalogue and chart of 212 stars, which are within a distance of ten minutes from the position of Tycho's star. This catalogue is for the year 1865, and it will serve for a standard of reference in case Tycho's star should again blaze out. Mr. J. R. Hind, of England, by the reduction of a part of Tycho's observations, found the position of the new star to be for 1865,

$$\text{A.R.} = 4^\circ\ 16'\ 48'': \text{Decl.} = +\ 63^\circ\ 23'\ 5''.$$

(Monthly Notices, Royal Astronomical Society, Vol. 21, p. 233.) From a more complete reduction of Tycho's observations Argelander found for 1865,

$$\text{A.R.} = 4^\circ\ 19'\ 58'': \text{Decl.} = +\ 63^\circ\ 23'\ 55''.$$

(Astronomische Nachrichten, Band 62, p. 274.) This position agrees very well with that of a small star of the 10½th magnitude, which is No. 123 of D'Arrest's catalogue. The position of this small star for 1865 is,

$$\text{A.R.} = 4^\circ\ 19'\ 30'': \text{Decl.} = +\ 63^\circ\ 22'\ 54''.$$

When we remember that Tycho's observations were made without the aid of telescopes or of any magnifying power, we may consider the difference of these positions as within the limits of the probable error of his determination. We conclude, therefore, that Tycho's star is still visible in our telescopes, and that its brilliant appearance in 1572 was only an extreme case of the variations of light that are frequently happening among the stars.

John Goodricke, an English astronomer, who in 1782 determined the period of the variability of the famous star Algol, thought that Tycho's star might be the same as the new stars reported to have been seen in the years 945 and 1264. This would make the period of its variability between 300 and 320 years, and hence this star should re-appear in the latter part of the present century. Goodricke's conjecture seems to be very uncertain, since the reports for the years 945 and 1264 are extremely vague. It will be seen that if we assume the period of the variability of Tycho's star to be 315 years, five such periods would carry it back to near the beginning of the Christian era. Astrologers and others have not been slow to catch at such analogies, and to base predictions on these uncertain data; and thus we have it asserted that Tycho's star is identical with the star of Bethlehem, and that it will re-appear in the year 1887, with wars and social revolutions. Of course it is impossible to reply to such assertions. Wars and social revolutions are continually going on, and such grim predictions are as safe therefore, as it is to say, that to-morrow the winds will be variable, or that we shall have "rain in areas;" or snow next January. The only wonder is that intelligent people are imposed on by such assertions.

At the present time more than a hundred variable stars are known to astronomers, and every year increases their number. Many of their periods are well determined, but what causes the variations of light we do not know. The so-called new stars may be only extreme cases of the variable stars, and the appearance of one is an interesting astronomical phenomenon which should be carefully observed. There is a rich field for observation and for study.

A. HALL.

WASHINGTON, D.C., Nov. 29, 1880.

NEW YORK ACADEMY OF SCIENCE.

We direct special attention to the excellent course of lectures provided by the New York Academy of Sciences, to which non-members are admitted free, on making application to the proper authorities.

The lecture for Monday next, December 6th, will be delivered by Professor W. Boyd Dawkins, F. R. S., of Owens College, Manchester, England, the subject being "The Man of the Caves."

We understand the present will be the only opportunity for hearing Professor Dawkins lecture in this country on a subject on which he is a specialist. We anticipate a large attendance.

The present efforts of the executive of the New York Academy of Science, under the presidency of Professor Newberry, to provide a course of free lectures of the highest order, should be fully recognized by all interested in Science and we advise those who would avail themselves of the opportunity to address Professor D. S. Martin, of 23) West Fourth street; or Professors W. P. Trowbridge and Alexis A. Julien, both of Columbia College, N. Y., as these gentlemen constitute the Committee on Lectures.

HISTORICAL NOTES ON GAS ILLUMINATION.

At the present moment when the public is all impatience to see the electric light perfected for general illuminating purposes, it may be interesting to note a few particulars descriptive of the early days of gas, when it struggled into existence for the same purposes.

In looking over a few somewhat ancient scientific papers I found much relating to the subject, and will now reproduce these historical facts in the order in which I found them.

It appears that in the British Museum there is preserved a paper (Ascough's Cat. 4437), entitled "Experiments Concerning the Spirit of Coals, in a Letter to the Hon. Mr. Boyle, by the late Rev. James Clayton, D.D., B. Mus." These experiments were undertaken by him in consequence of his having observed that the gas, issuing from certain fissures near a coal pit at Wigan, in Lancashire, took fire when a burning candle was presented to it. He therefore distilled coal, and obtained first "phlegm," afterwards a black oil, and then "an inflammable spirit," which he collected in bladders. By pricking these bladders he was able to ignite the gas at pleasure. Hence it is evident that the discovery of the carburetted hydrogen gas took place previous to the year 1664.

So states a paper, No. 66, in the *Philosophical Journal*, by Mr. John Webster, "*On the Discovery of the Inflammable Gas from Coals;*" the date of the paper is not before me, but its republication, in the form I found it, was in 1807.

In the *Phil. Jour.*, No. 67, the subject is again mooted by a Mr. Hume, who states that in the forty-first volume of the Philosophical Transactions, p. 59, is a "sheet-paper," which appears to have been read before the Royal Society in January, 1739, as "A Letter to the Hon. Robert Boyle, from the late Rev. John Clayton, D.D., in which is described how the discovery originated, and also some of the effects produced by this gas or 'spirit' of coal."

Mr. Hume further draws attention to the difference in the Christian names given to Mr. Clayton, in the first instance "James" and the second "John," and draws the very probable conclusion that the same person is referred to in both papers, and states, "At any rate, the merit of this discovery can be no longer claimed by any living person."

This remark was called forth on account of the public papers of that day, 1808, being much taken up with the proposal of a Mr. Winsor to light cities with gas. It appears that Mr. Edward Heard also obtained a patent in June, 1806, for "Obtaining inflammable gas from pit coal, in such a state that it may be burned without producing any offensive smell."

There was money in this patent, for Mr. Winsor was organizing a large company, which was not to buy the patent, but to pay a royalty as a license for the exclusive right to make use of it. As usual in such cases there was a great outcry, and the attempt was made to break down the patent by asserting that the invention was not new, one Nicholson taking the ground that the patent was invalid, because the inflammable nature of coal gas was demonstrated by "Boyle" before 1691; and he further stated that Lord Dundonald used gas from coal to give light many years ago, and that a Mr. Murdock also put it in practice upon a large scale in 1792 and 1798, so that it was absurd for Mr. Winsor to claim the invention for the public use of gas.

To parry these attacks Mr. Winsor published a small pamphlet, and boldly asserted that it was true that the inflammability of coal gas had been long known, but that no one *had purified gas*, and thus made it fit for general illuminating purposes, until he took out his patent in 1804. He also accused others, who were in the field, of having obtained their knowledge from him.

Mr. Winsor had to contend against other difficulties; for, at that date, the statute law of the realm prohibited more than five persons holding a patent as joint property, and it was held that as the shareholders of the proposed company would share the profits, they would be joint holders of the patent. To this Mr. Winsor replied that he retained the patent himself and merely sold the right to use it. To show the poor prospects for gas illumina-

tion entertained in those days, the remark of the editor who published these papers is significant, for he says he "regards the whole scheme as a bubble."

The next paper before me "On the Application of the Gas from Coal to Economical Purposes," by Mr. William Murdock—*Phil. Trans.*, 1808, shows the question to have advanced to the stage when a large building had been illuminated by gas; this building was the cotton manufactory of Phillips and Lee, of Manchester, England, the whole of which, together with the dwelling house of Mr. Lee, was lighted with gas.

This was thought, at the time, to be a great feat, and shows by what slow degrees the process of gas illumination was developed; the idea of a central manufactory of gas, and that of carrying it by pipes throughout a district, never entered the minds of the most advanced advocates of the system, but that each house or establishment should manufacture its own gas and use it, was considered the perfection of gas lighting.

Mr. Lee distilled the coal in large iron retorts, and the gas was conveyed into large gasometers, where it was washed and purified, and then conveyed to the burners. There were 271 burners on the principle of the Argand lamp, each of which gave a light, as measured by means of shadows, equal to four mould-candles of six to the pound; and 633 burners, called cockspurs, having three apertures only of 1-30th of an inch, and of which the light was equal to two and a quarter of the same candles; so that the whole of the lights were equal to 2,500 candles of that size, each of which consumed 4-10ths of an ounce, or 175 grains of tallow in an hour. Mr. Murdoch continues, "the quantity of gas required by this number of burners was 1250 cubic feet in an hour. In some mills where the work is light, the average time required will be three hours, but in this manufactory the yearly averages is two hours a day, or 2,500 cubic feet of gas. This quantity of gas required the distillation of 7 cwt. of cannel coal." The expense of the lights used in this manufactory may therefore be stated thus:

Cost of 110 tons of best Wigan cannel, at 22s. 6d. is		£123
Cost of 40 tons of common coals to heat the retort at 10s. is		20
		£143
Interest on capital, and wear and tear of apparatus		550
Attendance, the same as when candles are used, therefore need not be stated		0
		£693
Deduct value of 70 tons of coke	£93	
Value of 1250 ale gallons of tar not yet sold	0	£93
		£600

"The expense of candles to give the same light would be, at 1s. per lb., nearly £2,000. The light is peculiarly soft and clear, and of almost unvarying intensity, so as to be very pleasant to the workmen. It is also free from the danger of spark."

This will give an idea of the method of making comparative calculations then used to determine the merits of gas as against the use of candles. The editorial remarks on this paper, might, if the word gas be substituted for electricity, be taken for one of the criticisms so lately in fashion, and now a little obsolete.

"The present paper furnishes the necessary data for calculating the quantity of coals that would be required to yield a light equal to that of a given number of candles; and it affords an easy means of investigating the economical advantages of this process, which seems well adapted to the illumination of public buildings, large manufactories, and generally speaking, all establishments where a great number of lights are required; but we fear the *expense of the apparatus will always be against its introduction in domestic establishments* on a small, or even middling scale."

The last paper I notice is "*On the Advantage* of Employing Coal-gas for Lighting Small Manufactories, and for Other Purposes," by Mr. B. Cook, *Philosophical Journal*, No. 94.

Mr. Cook in this paper drew attention to the increased price of tallow, on account of the "rupture with Russia," so that the advantage of using coal-gas becomes evident. It is true, he says, that coal itself might increase in value, but, as he suggests, it might lead to an increased search and greater production.

Mr. Murdock explains the method of making gas for large manufactories, and Mr. Cook in his paper describes his plan for making gas for dwelling houses. "Such an apparatus," he says, "should be an 8 gallon iron pot, with a cover of the same metal luted on with sand. About 20 to 25 pounds of coal are put into the pot, and distilled, which requires the combustion of about 25 pounds more of coals. The quantity of gas varies with the quality of the coals, it is passed through water into the reservoir, which only holds about 400 gallons, but in general more is produced; so that the overplus, perhaps 200 gallons, is wasted. From the reservoir the gas is conveyed round the house by means of old gun barrels, used as tubes, and coated once a year, or seldomer, with the produced tar.

"The gas flame is found superior to that of a lamp for soldering with the blow-pipe. The moment the stop-cock is turned on, the frame is ready for use, while with oil or cotton wick, the workmen are forced to wait until the lamp is sufficiently on fire."

The expense of this apparatus was £50, but he thought others could be put up for £40.

In regard to the light produced, Mr. Cook offers the following facts: "The lights employed in the manufactory are 18 or 20, equal to eighteen shillings a week for candles, for 20 weeks, which amounts to £18. It used to cost £30 a year for oil and cotton for the soldering lamps; and the coke is certainly worth £2, 10*s*. a year, so that, setting the tar against any little accident that may happen, the whole produce may be taken at £50. 10*s*. a year.'

Supposing 50 lbs. of coal are used daily, the weekly expenditure on that head will be 2 shillings, and allowing part of a man's time to attend to making the gas to be worth 5 shillings, the whole will be 7 shillings per week or £18, 4 shillings a year; this however is one fourth more than it ought to be, because for 25 to 30 weeks the gas will not be required for lights. And adding to this expense £2 a year for interest on the cost of the apparatus, there will remain a saving of £30. 6s. in the year.

For a family using only six candles and one lamp, a gas apparatus would cost from £10 to £12, the cost of which will be saved during the first year.

The critical remark of the editor of this paper is truly amusing, for, by a train of reasonining, he states that he is compelled to oppose the introduction of gas, because *it will raise the price of butchers' meat.* The editor argues that if gas supersedes candles, the price of tallow will fall; therefore, as the fat of animals will be reduced in value, butchers will have to charge a higher price for the leaner portion of the meat, so as to realize the value of the beasts. "*Therefore, as food is of more consequence than artificial light, it is rather to be depreciated.*"

A year later Mr. Cook read a second paper "On the Advantages of Coal Gas Light" (*Phil. Trans.* 98), which shows that the methods of preparing the gas was very imperfect, and an unpleasant oder was given off when it was used. In regard to this, Mr. Cook says, in reference to this objection that the smell occasioned by the gas is injurious to health, and that "it rather tends to preserve

health by destroying contagion, *and purifying the air.*"

This absurd statement appeared to give satisfaction to the editor, who in his observations on the paper states: "Information of this kind has long been wanted, and those who have made the greatest bustle on the wonderful advantages attending the use of the gas light have, in this respect, been deficient." Possibly public opinion was leaning towards the introduction of gas, for the same editor, who in 1809 observed, on Mr. Murdock's paper, that "the expense of the apparatus will always be against its introduction on a small or middling scale," now observes, in 1810, "The statement of Mr. Cook clearly proves the great advantages connected with those lights, *even on a small scale.*"

It is not intended that the foregoing represents the history of the introduction of gas for illuminating purposes, but it gives phases of the question which are of interest at this moment, and shows that, as in the introduction of the electric light for the same purpose, its development was very gradual. It will be seen that the economy of both gas and electricity for lighting purposes was at first disputed, both were afterwards considered only adapted for large buildings, then came the time when each was shown to be fitted for domestic purposes. The introduction of gas was considered "*a bubble,*" and when all other objections had been exhausted, scientific testimony of that day finally stated that gas lighting would raise the price of beef. When gas lighting was first introduced, the idea of a great central manufactory for a city was not even dreamed of; possibly at that time the mere suggestion of such a design would have caused a panic; but that it was successfully accomplished we all know. Gas was also first used for lighting large buildings, but it required the genius of one man to invent a process for its purification, so as to make it practical for general illuminating purposes.

The reader, with a knowledge of recent events, can easily compare them with the facts here recorded respecting the early days of gas, and notice how history has again repeated itself.

First the possibility of using the electric light for general illuminating purposes was denied, then its adaptability for large buildings was admitted, and now finally its use for domestic purposes is unquestioned.

The economy of electric lighting was also assailed, but the arguments are now getting stale. As each consumer had at first to make his own gas, so the first idea of electric lighting was coupled with the necessity on the part of each consumer to own his own electric generator and it was reserved for Edison to reform the whole system, and put it on a practical footing. He first publicly exhibited an electric lamp, that could compete with gas, and that was adapted for the general illumination of houses by electricity; he first subdivided the electric current, and thus demonstrated that its economic use was a possibility, and he will be the first to achieve the final triumph of establishing a central station for the manufacture of electricity and conducting it to the houses of the people.

Capitalists combining with scientific experts and patent pirates may endeavor to strip Edison of the honors due to him, earned by patient and exhaustive study of the question. That the electric light would eventually supersede gas for general illuminating purposes, no one doubted, but that Edison by bringing to bear upon it his great inventive powers, combined with almost unlimited resources, has advanced the time for accomplishing the result by at least fifty years, will be admitted by all unprejudiced persons. J. M.

THE DISTRIBUTION OF TIME.

By Professor Leonard Waldo.

From time to time within the last twenty years there have appeared articles in the public prints which indicated an awakening and growing interest in the practicability of having wide sections of our country transact its business and govern its social duties by a common time. Within the last few years official reports from various observatories, departments of the Government, scientific societies and telegraph companies, have shown so considerable a progress in the introduction of uniform systems of time, and these systems have been so cordially received by the communities interested, that there can be no doubt that the country is ready to be divided into a few great sections, each of which shall be governed by its own standard, which shall bear some simple relation to the standards governing the neighboring sections.

The principal systems now in operation comprise the United States Naval Observatory system, which extends its distribution of Washington time to Chicago and the West; the Harvard and Yale systems, which distribute, respectively, Boston and New York time over New England; the Alleghany Observatory system, which is concerned chiefly with the Pennsylvania Railroad; and the more local services emanating from the observatories at Albany, Chicago, Cincinnati, and St. Louis. Unfortunately, except in New England, the distribution of the time of an observatory has not always resulted in the adoption of that time for general use, and it is often the case that the local jewelers who are guardians of town clocks, and local time as well, will convert the time received by telegraph into their own local time, and thus make it inconveniently different from the time in use in any other city of their region.

A railroad may or may not secure the adoption of its own time in the cities along its route. It is generally a question as to which is the most important, the railroad or the town. But certain it is that there is not an important railroad in the country, outside of New England, along which the commercial traveler may go without having to compute the discrepancy between his watch and the time kept by the business men at one-half of the stopping-places. Thus it happens that, even where cities are closely connected by large railroads, the people have been dictated to by their jewelers regarding their standard of time, when a little reflection shows that there is only a very questionable advantage arising from having a local time simply because the jewelers of the city insist on a time which shall appeal to the local pride of their customers.

On the other hand, the disadvantage of having the factory operatives begin work on railroad time and stop on local time, because they gain ten minutes a day by that sharp practice; the jostle and inconvenience in the commercial interchange between two neighboring cities, because the stock exchanges, business offices and the banks, close with a difference of ten minutes; the thousand engagements broken by the discrepancies of time—all indicate the need of the adoption of such a common time as already exists in the European countries.

The writer has always felt that the railroads ought to be the most influential means in securing uniformity. They can be successfully appealed to for the financial support which any accurate system demands, because they have a direct and strong interest in the use of the same time at every office and by every employee of their roads. The superintendents, too, with whom the decision of such matters generally rests, are keenly alive to anything which lessens the risk of accident, and they at once appreciate the advantage of having the clocks of intersecting roads, and of the towns through which their roads pass, all indicate the same time. The control of a telegraph wire for railroad business gives them the means of transmitting time-signals, and in New England it is the railroads which have virtually caused the all but universal acceptance of the Boston and New York standards referred to. Outside of New England there has been scarcely any concert of action among the railroads, and there are about seventy different standards of time in use. The result of the experiment in New England fairly just-

ifies the belief that, were the railroads in the rest of the United States approached on this question, they would combine to adopt the standards of time now used by a few of the great centres of population. Thus, while it was found quite impossible to unite the New England roads upon Boston time, and while it would have been equally impossible to cause the Boston roads to run on New York time, it has proved highly satisfactory to allow the current of travel, which always drifts toward the nearest centre of population, to decide the matter. To bring into use in a large section of the country two standards, where before there has been a dozen, is the first step toward uniting the two into one; and, in the writer's opinion, it is only by a gradual amalgamation of different local times that the final adoption of a few standards for the whole country can be effected. As a rule, railway corporations are more intelligent on this subject than the town councils which are elected by popular suffrage. They are also urged to encourage uniform time by their own interests. They are under the direct influence of State legislation, and the agreement of a number of railroads can be made to influence the communities of the regions traversed to use the railroad standard. Whether the pressure of State legislation ought to be used is an open question. It has been the writer's experience that the railroads are quite willing to do their part without recourse to any such means; and with the average railroad official the fact that a service is to be enforced by legislation prejudices him against it.

The difficulties in the way of introducing a new standard would still further be reduced if the observatories universally took care to distribute a time which should be as accurate as human art could make it, and use only such simple means of rendering it available as could allow of no vitiation of the message over the time-telegraph wires. By so doing the observatories would, so to speak, have a monopoly of the best article in the market, for no private jewelers could hope to furnish the local time with the precision obtained in a first-class observatory, where every means is taken to insure accuracy. There is, however, little use in trying to supplant a local time which is furnished by a respectable jeweler who takes good care of a good clock, and who has acquired the art of determining his time carefully, if the new system of signals is not to be relied upon within a single second. Unfortunately, the example set the time-services of the country, by that under the direction of the Naval Observatory at Washington, is not of the best; and, until it is realized by the proper officers that a division of responsibility in the charge of delivering time-messages results in the inaccuracy of the service to the public, the services organized under the control of universities will occupy the first place for accuracy.

The best, because the most unmistakable in its indications, of the means yet proposed for the distribution of a public time consists in the ordinary telegraph receiving-instrument, which is brought into circuit with the observatory clock at stated intervals. The clock then automatically beats in such a manner as to indicate the beginning of the minute, or of the five minutes, which have been agreed upon for the reception of the time by telegraph.

Experience has shown that the average railroad employee or telegraph operator very quickly apprehends this method of transmission, and, since the clock effects the distribution automatically, if the signals are received at all they must be exact. The very tempting method of propelling the hands of clocks by electricity has never been successfully applied over extended areas; and the nearest approach to an accurate service from a distant observatory takes place when the pendulum of the clock at a distance from the observatory is moving in sympathy with the observatory clock, through the action of induced electrical currents. A very good example of this kind may be seen in the Treasury clock, at Washington, where one of the Observatory clocks controls it, beat by beat, through the intervention of a mile of telegraph-wire. In this system, which is commonly known as Jones's system, the interruption of the telegraphic circuit, by storms or otherwise, does not cause the controlled clock to stop, as in the systems above referred to; but one can never be sure, when the current is restored, that the controlled clock will not have deviated during the stoppage of its control; and this method has not proved successful where high accuracy is demanded, or the telegraph lines are liable to such interruptions as are common in our climate. This method, however, has found considerable favor in England, and the writer had little difficulty in using a clock, so controlled, at the end of a well-protected wire four miles distant from the Observatory of Harvard College. It was not, however, perfectly reliable, and errors of from two to ten seconds were sometimes found to exist in the controlled clock.

Of the new method, which originated, we believe, in Vienna, and has made its way as far westward as Paris, of setting clocks by means of pneumatic tubes, there can be a great deal said on the score of economy, when the system is applied to large cities. It certainly would be a popular idea to have the time laid on, as the water or gas is, from a small pipe passing the door. The special clock needed would be furnished and kept in order by the small payment of a small annual rental. The expense would be trifling as compared with any system yet suggested of equal accuracy, and the field is so promising that it would be strange if attempts were not soon made in our large cities to occupy it. But such or any similar systems for the local distribution of time will depend upon the accurate and regular reception of the standard from an observatory which may be several hundred miles distant; and for this principal service, as well as for the railroads, the writer has already expressed the opinion that the transmitting and receiving apparatus of the telegraph companies, in connection with an observatory clock, affords the best, as well as the simplest, means.

So much for the public distribution for commercial and social purposes. There is another and extremely important service, too much neglected in our country, in behalf of the merchant marine. The Royal Observatory at Greenwich justly considers the accurate dropping of the time-balls on the English coast of almost equal importance with the transmission of time over England. A similar service should be undertaken by our own Naval Observatory, and the suggestions embodied in Professor Holden's report to the Secretary of the Navy*, on this subject, receive the cordial support not only of the officers of the navy and of the merchant marine, but of those men of science whose attention has been called to the lack of such a service at the important ports of Philadelphia, Baltimore, and San Francisco.

Such a service is performed for the port of New York, though not with the assurance of accuracy we have a right to expect in such a Government work. The Observatory of Harvard College, in connection with the United States Army Signal Service, drops a time-ball for the benefit of Boston Harbor, and perhaps there is no one public signal of the Harvard Time Service which is received with more public favor than this, not only by the commanders of vessels lying in the harbor, but by the people living on the surrounding highlands, and numerous factories and institutions from which the signal is visible. This signal owes its existence to the public spirit shown by the Equitable Life Insurance Company, of New York, in erecting the apparatus necessary upon the top of their magnificent building. The time-balls in Boston, New York, and Washington, have thoroughly ingratiated themselves in the public favor.

The cost of the construction of a time-ball of the

* Report of the Secretary of the Navy, Second Session, Forty-fourth Congress.

best materials and of sufficient size, with the electrical apparatus necessary, is about a thousand dollars, and, although it is the most accurate signal for popular use, yet the time-gun has many advantages, on the score of economy and convenience, over the more exact time-ball. The time-gun could be extemporized from one of a battery, at any place where there is a detachment of the artillery service permanently located. Of course, there is an error owing to the time required for the sound to traverse the distance from the gun to the hearer, but this is insignificant for ordinary purposes, and it is not necessary to take any other trouble than to merely listen for the report of the gun which is known to be discharged by an electrical current from some observatory at an arbitrary instant. The time-guns have shown themselves to be very popular in Great Britain and on the Continent; and if our army, either through its Signal Service or the artillery, could act in concert with observatories in different parts of the country, the discipline necessary for the efficient performance of such a service would be obtained, and the service would be extremely popular among the people.

Doubtless the Naval Observatory could assist in distributing the time to the whole country, but there are several reasons why it would be inexpedient for many years to come. That observatory has a legitimate sphere in fostering astronomical science throughout the country, and in performing such services as are directly for the benefit of the navy and other Government offices.

There are several observatories, particularly in our Western cities, which rely for a large share of their hold of the popular sympathy upon the public time-signals which they furnish. So long as they are strongly interested in the growth of their local service, they will do missionary work for science by interesting the people in the observatory which gives them their time.

Now, let these communities be approached through the offices of the telegraph companies acting as the agents of the Naval Observatory, and the majority will at once feel, with some truth, that the matter is no longer one of science and the patronage of a local or State institution, but that the telegraph companies are urging for their own profit the introduction of a service for which the people have not sufficient need to pay the price charged. In support of this view it might be mentioned that under date of April 2, 1877, our most promiment Telegraph Company issued an official circular through the agency of its principal local offices throughout the United States, which urged the importance of accurate time, and made financial proposals to furnish the Naval Observatory time to seventy-eight cities of the United States once a day, at a charge varying from seventy-five to five hundred dollars per year for each place. So far as the writer knows, there has not been a single acceptance of these proposals, and even one or two acceptances might be considered exceptions to a rule. Another difficulty is the cost of the service to cities which are far distant from the distributing office. The telegraph companies justly claim that this service ought to be paid for at a higher rate than ordinary business messages because it is preferential, and all other business must cease at a given time. This arbitrary stoppage may sometimes prove highly inconvenient, and presupposes a thoroughness of discipline among employees which it is difficult to maintain over the long lins of our Western country. The service to be popular must be quick to redress grievances, and accommodating in the details of its work, particularly at its initiation. It is evident that these agencies are best insured by having the friendship toward the observatory of an important class in the community somewhat dependent on the efficiency of its time-service.

The furnishing of correct time is educational in its nature for it inculcates in the masses a certain precision in doing the daily work of life which conduces, perhaps, to a sounder morality. and this idea will not seem far-fetched if we consider how strikingly indicative of the character of a people in the scale of civilization is the promptness with which they transact their business. It is felt, therefore—and particularly in New England—that the university does a creditable action when it directly encourages the distribution of time from its observatory. This view will be adopted by the Wstern institutions of learning as they gradually rise to the dignity of having distinct observatories connected with them.

At the last meeting of the American Association for the Advancement of Science, in Boston, a committee was appointed to urge the adoption of uniform systems in various parts of the country. This committee includes the representatives of the observatories which have dode most in this cause.

The American Metrological Society, through a committee, have presented a carefully prepared report on the present condition of this question in the United States.* It is the opinion of that committee that the standards of time for the various parts of the country should differ by even hours, beginning with the meridian which is just four hours west of Greenwich, and designating the systems as in the last column of the following table:

PROPOSED SCHEDULE OF STANDARDS OF TIME.

Geographical Section.	Standard Meridian.	Time Slower than Greenwich.	Designation.
Newfoundland New Brunswick Nova Scotia, etc	60° west.	4 h. 0 m. 0 s.	Easern time.
Canada Atlantic States Ohio to Alabama Lower Lakes	75° "	5 h. 0 m. 0 s.	Atlantic time.
Mississippi Valley Missouri Upper Lakes Texas	90° "	6 h. 0 m. 0 s.	Valley time.
Rocky Mountain regions	105° "	7 h. 0 m. 0 s.	Mountain time.
Pacific Slope British Columbia Vancouver's Island	120° "	8 h. 0 m. 0 s.	Pacific time.

The constitution of both of these committees is such that they would favor the distribution of standards of time according to any such scheme as the preceding, rather than the distribution of a single time from the Naval Observatory. The above scheme, in the opinion of those who have given much thought to the subject, is the best one so far presented. It was due originally to Professor Benjamin Peirce, and its great merit consists in there being no greater difference than half an hour in any part of the country between the true local time and the arbitrary standard—an amount but slightly greater than exists between Greenwich and the west of England. In passing from Ohio into the Mississippi Valley, for instance, the traveler merely changes his watch by one hour; and the merchant, remembering that Pacific time is three hours slow of Atlantic time, knows that it is half-past two in San Francisco when it is half-past five in New York.

Any scheme which proposes the adoption of a uniform time from one extremity of the country to the other must be looked upon as chimerical for a century to come. Ten o'clock in the morning at once conveys to our minds an idea of the average occupation of our people at that time; it is associated with a certain brightness of daylight; it means that the working classes have been occupied with their daily task about three hours; we expect to find the majority of banks and shops open; and any disturbance of these traditional times would be received with marked disfavor. To learn, for instance, from the morn-

* Proceedings of the Metrological Society, vol. ii. New York; Published by the Society.

ing paper that a distinguished public man had arrived in San Francisco late in the evening, and, fatigued with his journey, had retired at seven o'clock, would give the Eastern reader a sense of the utter strangeness of keeping a time three hours different from local time.

Any action for the establishment of standards of time over the country must begin by securing the active coöperation of the telegraph companies. The most influential of these companies has been traditionally public-spirited in allowing the use of its wires for scientific purposes, often at considerable expense to itself. The service of transmitting time occupies at present such an extremely small proportion of its ordinary business that the company has not as yet an officer of its service empowered to carry out the details necessary for such time-distributions as have been already discussed. If, however, the committees referred to could prepare a scheme that was thoroughly practical, and agree upon a uniformity of details which should not seriously interfere with the ordinary business of this or any other company, it is believed that the company would find it to their own interest to establish a regular system of procedure to govern their action in the case of observatories in different parts of the country which desire to secure their services in transmitting time-signals. In consideration of the assumption of responsibility and the efforts at introduction made by the observatory, the company would probably be found willing to so adjust their charges that it would prove to be entirely practicable for the various observatories to secure a large patronage for the services emanating from them without the financial burden seeming an undue amount.—*North Am. Rev.*

[*Continued from page* 270.]

THE UNITY OF NATURE.

By the Duke of Argyll.

III.

ANIMAL INSTINCT IN ITS RELATIONS TO THE MIND OF MAN.

All the knowledge and all the resource of mind which is involved in these instincts is a reflection of some Agency which is outside the creatures which exhibit them. In this respect it may be said with truth that they are machines. But then they are machines with this peculiarity, that they not only reflect, but also in various measures and degrees partake of, the attributes of mind. It is always by some one or other of these attributes that they are guided—by fear, or by desire, or by affection, or by mental impulses which go straight to the results of reasoning without its processes. That all these mental attributes are connected with a physical organism which is constructed on mechanical principles, is not a matter of speculation. It is an obvious and acknowledged fact. The question is not whether, in this sense, animals are machines, but whether the work which has been assigned to them does or does not partake in various measures and degrees of the various qualities which we recognize in ourselves as the qualities of sensation, of consciousness and of will.

On this matter it seems clear to me that Professor Huxley has seriously misconceived the doctrine of Descartes. It is true that he quotes a passage as representing the view of "orthodox Cartesians," in which it is asserted that animals "eat without pleasure and cry without pain," and that they "desire" nothing as well as "know" nothing. But this passage is quoted, not from Descartes, but from Malebranche. Malebranche was a great man; but on this subject he was the disciple and not the master; and it seems almost a law that no utterance of original genius can long escape the fate of being travestied and turned to nonsense by those who take it up at second hand. Descartes' letter to Moore, of the 5th February, 1649, proves conclusively that he fully recognized in the lower animals the existence of all the affections of mind except "Thought" (*la Pensée*), or Reason, properly so called. He ascribes to them the mental emotions of fear, of anger, and of desire, as well as all the sensations of pleasure and of pain. What he means by thought is clearly indicated in the passage in which he points to Language as the peculiar product and the sole index of Thought—Language, of course, taken in its broadest sense, signifying any system of signs by which general or abstract ideas are expressed and communicated. This, as Descartes truly says, is never wanting, even in the lowest of men, and is never present in the highest of the brutes. But he distinctly says that the lower animals, having the same organs of sight, of hearing, of taste, etc., with ourselves, have also the same sensations, as well as the same affections of anger, of fear, and of desire—affections which, being mental, he ascribes to a lower kind or class of Soul, an "âme corporelle." Descartes, therefore, was not guilty of confounding the two elements of meaning which are involved in the word machine—that element which attaches to all machines made by man as consisting of dead non-sentient matter—and that other element of meaning which may be legitimately attached to structures which have been made, not to siumlate, but really to possess all the essential properties of Life. "Il faut pourtant remarquer," says Descartes, emphatically, "que je parle de la pensée *non de la vie, ou de sentiment.*" [1]

The experiments quoted by Professor Huxley and by other Physiologists, on the phenomena of vivisection, cannot alter or modify the general conclusions which have long been reached on the unquestionable connection between all the functions of Life and the mechanism of the body. The question remains, whether the ascertainment of this connection in its details can alter our conceptions of what Life and sensation are. No light is thrown on this question by cutting out from an organism certain parts of the machinery which are known to be the seat of consciousness, and then finding that the animal is still capable of certain movements which are usually indicative of sensation and of purpose. Surely the reasoning is bad which argues that because a given movement goes on after the animal has been mutilated, this movement must therefore continue to possess all the same elements of character which accompanied it when the animal was complete. The character of purpose in one sense or another belongs to all organic movements whatever—to those which are independent of conscious sensation, or of the will, as well as to those which are voluntary and intentional. The only difference between the two classes of movement is, that in the case of one of them the purpose is wholly outside the animal, and that in the case of the other class of movement the animal has faculties which make it, however indirectly, a conscious participant or agent in the purpose, or in some part of the purpose, to be subserved. The action of the heart in animals is as certainly "purposive" in its character as the act of eating and deglutition. In the one the animal is wholly passive—has no sensation, no consciousness, however dim. In the other movement the animal is an active agent, is impelled to it by desires which are mental affections, and receives from it the appropriate pleasure which belongs to consciousness and sensation. These powers themselves, however, depend, each of them, on certain bits and parts of the animal mechanism; and if these parts can be separately injured or destroyed, it is intelligible enough that consciousness and sensation may be severed for a time from the movements which they ordinarily accompany and direct. The success of such an experiment may teach us much on the details of a general truth which has long been known—that conscious sensation is, so far as our experience goes, inseparably dependent upon the mechanism of an organic structure. But it cannot in the slightest degree change or modify our conception of what conscious sensation in itself is. It is mechanical exactly in the same sense in which we have long known it to be so—that is to say, it is the result of life working in and through a structure which has been made to exhibit and embody its peculiar gifts and powers.

Considering now that the body of man is one in structure with the body of all vertebrate animals—considering that, as we rise from the lowest of these to him who is the highest, we see this same structure elaborated into closer and closer likeness, until every part corresponds, bone to bone, tissue to tissue, organ to organ—I cannot doubt that Man is a machine, precisely in the same sense in which animals are machines.

[1] "Œuvres de Descartes," Cousin, vol. x. p. 205 *et seq.*

If it is no contradiction in terms to speak of a machine which has been made to feel and to see, and to hear and to desire, neither need there be any contradiction in terms in speaking of a machine which has been made to think, and to reflect, and to reason. These are, indeed, powers so much higher than the others that they may be considered as different in kind. But this difference, however great it may be, whether we look at it in its practical results, or as a question of classification, is certainly not a difference which throws any doubt upon the fact that all these higher powers are, equally with the lowest, dependent in this world on special arrangements in a material organism. It seems to me that the very fact of the question being raised whether Man can be called a machine in the same sense as that in which alone the lower animals can properly be so described, is a proof that the questioner believes the lower animals to be machines in a sense in which it is not true. Such manifestations of mental attributes as they display are the true and veritable index of powers which are really by them possessed and enjoyed. The notion that, because these powers depend on an organic apparatus, they are therefore not what they seem to be, is a mere confusion of thought. On the other hand, when this comes to be thoroughly understood, the notion that Man's peculiar powers are lowered and dishonored when they are conceived to stand in any similar relation to the body must be equally abandoned, as partaking of the same fallacy. If the sensation of pleasure and of pain, and the more purely mental manifestations of fear and of affection have in the lower animals some inseparable connection with an organic apparatus, I do not see why we should be jealous of admitting that the still higher powers of self-consciousness and reason have in Man a similar connection with the same kind of mechanism. The nature of this connection in itself is equally mysterious, and, indeed, inconceivable in either case. As a matter of fact, we have precisely the same evidence as to both. If painful and pleasurable emotions can be destroyed by the cutting of a nerve, so also can the powers of memory and of reason be destroyed by any injury or disease which affects some bits of the substance of the brain. If, however, the fact of this mysterious connection be so interpreted as to make us alter our conceptions of what self-consciousness, and reason, and all mental manifestations in themselves are, then indeed we man well be jealous—not of the facts, but of the illogical use which is often made of them. Self-consciousness and reason and affection, and fear and pain and pleasure, are in themselves exactly what we have always known them to be; and no discovery as to the physical apparatus with which they are somehow connected can throw the smallest obscurity on the criteria by which they are to be identified as so many different phenomena of mind. Our old knowledge of the work done is in no way altered by any new information as to the apparatus by which it is effected. This is the error commttted by those who think they can found a new Psychology on the knife. They seem to think that sensation and memory, and reasoning and will, become something different from that which thiterto we have known them to be, when we have found out that each of these powers may have some special "seat" or "organ" in the body. This, however, is a pure delusion. The known element in psychology is always the nature of the mental faculty; the unknown element is always the nature of its connection with any organ. We know the operations of our own minds with a fullness and realty which does not belong to any other knowledge whatever. We do not know the bond of union between these operations and the brain, except as a sort of external and wholly unintelligible fact. Remembering all this, then, we need not fear or shrink from the admission that Man is a reasoning and self-conscious machine, just in the same sense in which the lower animals are machines which have been made to exhibit and possess certain mental faculties of a lower class.

But what of this? What is the value of this conclusion? Its value would be small indeed if this conception of ourselves as machines could be defended only as a harmless metaphor. But there is far more to be said for it and about it than this. The conception is one which is not only harmless, but profoundly true, as all metaphors are when they are securely rooted in the Homologies of Nature. There is much to be learnt from that aspect of mind in which we regard its powers as intimately connected with a material apparatus, and from that aspect of our own bodies in which they are regarded as one in structure with the bodies of the brutes. Surely it would be a strange object of ambition to try to think that we are not included in the vast system of adjustment which we have thus traced in them; that our nobler faculties have no share in the secure and wonderful guarantee which it affords for the truthfulness of all mental gifts. It is well that we should place a high estimate on the superiority of the powers which we possess; and that the distinction, with all its consequences, between self-conscious Reason and the comparatively simple perceptions of the beasts, should be ever kept in view. But it is not well that we should omit from that estimate a common element of immense importance which belongs to both, and the value of which becomes immeasurably greater in its connection with our special gifts. That element is the element of adjustment—the element which suggests the idea of an apparatus—the element which constitutes all our higher faculties the index and the result of a pre-adjustment harmony. In the light of this conception we can see a new meaning in our "place in Nature;" that place which, so far as our bodily organs are concerned, assigns to us simply a front rank among the creatures which are endowed with Life. It is in virtue of that place and association that we may be best assured that our special gifts have the same relation to the higher realities of Nature which the lower faculties of the beasts have to the lower realities of tne physical world. Whatever we have that is peculiar to ourselves is built up on the same firm foundation on which all animal instincts rests. It is often said that we can never really know what unreasoning instinct is, because we can never enter into an animal mind, and see what is working there. Men are so apt to be arrogant in philosophy that it seems almost wrong to deprecate even any semblance of the consciousness of ignorance. But it were much to be desired that the modesty of philosophers would come in the right places. I hold that we can know, and can almost thoroughly understand, the instincts of the lower animals; and this for the best of all reasons, that we are ourselves animals, whatever more;—having, to a large extent, precisely the same instincts, with the additional power of looking down upon ourselves in this capacity from a higher elevation to which we can ascend at will. Not only are our bodily functions precisely similar to those of the lower animals,—some, like the beating of the heart, being purely "automatic" or involuntary—others being partially, and others again being wholly, under the control of the will—but many of our sensations and emotions are obviously the same with the sensations and emotions of the lower animals, connected with precisely the same machinery, presenting precisely the same phenomena, and recognizable by all the same criteria.

It is true that many of our actions became instinctive and mechanical only as the result of a previous intellectual operation of the self-conscious or reasoning kind. And this, no doubt, is the origin of the dream that all instinct, even in the animals, has had the same origin; a dream due to the exaggerated "anthropomorphism" of those very philosophers who are most apt to denounce this source of error in others. But man has many instincts like the animals, to which no such origin in personal experience or in previous reasoning can be assigned. For not only in earliest infancy, but throughout life, we do innumerable things to which we are led by purely organic impulse; things which have indeed a reason and a use, but a reason which we never know, and a use which we never discern, till we come to "think." And how different this process of "thinking" is we know likewise from our own experience. In contemplating the phenomena of reasoning and of conscious deliberation, it really seems as if it were impossible to sever it from the idea of a double personality Tennyson's poem of the "Two Voices" is no poetic exaggeration of the duality of which we are conscious when we attend to the mental operations of our own most complex nature. It is as if there were within us one Being always receptive of suggestions, and always responding in the form of impulse—and another being capable of passing these suggestions in review before it, and of allowing or disallowing the impulses to which they give rise.

There is a profound difference between creatures in which one only of these voices speaks, and man, whose ears are, as it were, open to them both. The things which we do in obedience to the lower and simpler voice are indeed many, various, and full of a true and wonderful significance. But the things which we do and the affections which we cherish, in obedience to the higher voice have a rank, a meaning, and a scope which is all their own. There is no indication in the lower animals of this double Personality. They hear no voice but one: and the whole law of their Being is perfectly fulfilled in following it. This it is which gives its restfulness to Nature, whose abodes are indeed what Wordsworth calls them—

"Abodes where Self-disturbance hath no part."

On the other hand, the double Personality, the presence of "Two Voices," is never wholly wanting even in the most degraded of human beings—their thoughts everywhere "accusing or else excusing one another."

Knowing, therefore, in ourselves both these kinds of operation, we can measure the distance between them, and we can thoroughly understand how animals may be able to do all that they actually perform, without ever passing through the processes of augmentation by which we reach the conclusions of conscious reason and of moral obligation. Moreover, seeing and feeling the difference, we can see and feel the relations which obtain between the two classes of mental work. The plain truth is, that the higher and more complicated work is done, and can only be done in this life, with the material supplied by the lower and simpler tools. Nay, more, the very highest and most aspiring mental processes rest upon the lower, as a building rests upon its foundation stones. They are like the rude but massive substructions from which some great temple springs. Not only is the impulse, the disposition, and the ability to reason as purely intuitive and congenital in Man as the disposition to eat, but the fundamental axioms on which all reasoning rests are, and can only be, intuitively perceived. This, indeed, is the essential character of all the axioms or self-evident propositions which are the basis of reasoning, that the truth of them is perceived by an act of apprehension, which, if it depends on any process, depends on a process unconscious, involuntary, and purely automatic. But this is the definition, the only definition, of instinct, or intuition. All conscious reasoning thus starts from the data which this great faculty supplies; and all our trust and confidence in the results of reasoning must depend on our trust and confidence in the adjusted harmony which has been established between instinct and the truths of nature. Not only is the idea of mechanism consistent with this confidence, but it is inseparable from it. No firmer gronnd for that confidence can be given us in thought than this conception—that as the eye of sense is a mechanism specially adjusted to receive the light of heaven, so is the mental eye a mechanism specially adjusted to perceive those realities which are in the nature of necessary and eternal truth. Moreover, the same conception helps us to understand the real nature of those limitations upon our faculties which curtail their range, and which yet, in a sense, we may be said partially to overpass in the very act of becoming conscious of them. We see it to be a great law prevailing in the instincts of the lower animals, and in our own, that they are true not only as guiding the animal rightly to the satisfaction of whatever appetite is immediately concerned, but true also as ministering to ends of which the animal knows nothing, although they are ends of the highest importance, both in its own economy and in the far-off economies of creation. In direct proportion as our own minds and intellects partake of the same nature, and are founded on the same principle of adjustment, we may feel assured that the same law prevails in their nobler work and functions. And the glorious law is no less than this—that the work of instinct is true not only for the short way it goes, but for that infinite distance into which it leads in a true direction.

I know no argument better fitted than this to dispel the sickly dreams, the morbid misgivings, of the Agnostic. Nor do I know of any other conception as securely founded on science, properly so called, which better serves to render intelligible and to bring within the familiar analogies of Nature those higher and rarer mental gifts which we know as genius, and even that highest and rarest of all which we understand as inspiration. That the human mind is always in some degree, and that certain individual minds have been in a special degree, reflecting surfaces, as it were, for the verities of the unseen and eternal world, is a conception having all the characters of coherence which assure us of its harmony with the general constitution and the common course of things.

And so this doctrine of animal automatism—the notion that the mind of man is indeed a structure and a mechanism—a notion which is held over our heads as a terror and a doubt—becomes, when closely scrutinized, the most comforting and re-assuring of all conceptions. No stronger assurance can be given us that our faculties, when rightly used, are powers on which we can indeed rely. It reveals what may be called the strong physical foundations on which the truthfulness of Reason rests. And more than this—it clothes with the like character of trustworthiness every instinctive and intuitive affection of the human soul. It roots the reasonableness of faith in our conviction of the Unities of Nature. It tells us that as we know the instincts of the lower animals to be the index and the result of laws which are out of sight to them, so also have our own higher instincts the same relation to truths which are of corresponding dignity and of corresponding scope.

Nor can this conception of the mind of Man being connected with an adjusted mechanism cast, as has been suggested, any doubt on the freedom of the Will,—such as by the direct evidence of consciousness we know that freedom to be. This suggestion is simply a repetition of the same inveterate confusion of thought which has been exposed before. The question of what our powers are is in no way affected by the admission or discovery that they are all connected with an apparatus. Consciousness does not tell us that we stand unrelated to the system of things of which we form a part. We dream—or rather we simply rave—if we think we are free to choose among things which are not presented to our choice,—or if we think that choice itself can be free from motives,—or if we think that we can find any motive outside the number of those to which by the structure of our minds and of its organ we have been made accessible. The only freedom of which we are really conscious is freedom from compulsion in choosing among things which are presented to our choice,—consciousness also attesting the fact that among those things some are coincident, and some are not coincident, with acknowledged obligation. This, and all other direct perceptions, are not weakened but confirmed by the doctrine that our minds are connected with an adjusted mechanism. Because the first result of this conception is to establish the evidence of consciousness when given under healthy conditions, and when properly ascertained, as necessarily the best and the nearest representation of the truth. This it does in recognizing ourselves, and all the faculties we possess, to be nothing but the result and index of an adjustment contrived by and reflecting the Mind which is supreme in Nature. We are derived and not original. We have been created, or—if any one likes the phrase better—we have been "evolved:" not, however, out of nothing, nor out of confusion, nor out of lies,—but out of "Nature," which is but a word for the sum of all existence—the source of all order, and the very ground of all truth—the fountain in which all fullness dwells.

ASTRONOMICAL NOTES.

ON THE DETERMINATION OF THE VALUE OF ONE REVOLUTION OF A MICROMETER SCREW, ETC.

To determine the value of a revolution of a micrometer screw, it is desirable to use several different methods. The most common and least accurate is by the observation of the transits of stars over two wires of the micrometer, set at a known distance (in revolutions) apart. Mechanical measures, depending upon the measurement of the length of the screw, of the dimensions of the objective, and of the principal focal length of the telescope come next. The measures in arc of terrestrial objects of known linear dimensions come next. Bessel's triangulation of

the Pleiades was made, in part, so that the distances of any pair of these stars might be used as a known celestial arc to be determined in terms of the screw revolution. Dr. Vogel, of Potsdam, determined the value of the screw of the Leipzig refractor by measuring the difference of declination between two stars with the micrometer, and afterwards using the divided declination circle of the equatorial to determine the whole arc. This method was improved in the determination of the value of the screw of the Washington equatorial, by measuring with the micrometer the difference of declination of two *standard* stars (*ι* and *c Orionis*) a degree apart. In these last methods the value of the known arc in the sky depends upon our knowledge of the positions of its two terminal points. Dr. Winnecke, of Strassburg, has recently employed an ingenious way, which is even more simple. The distance between some asteroid (whose orbit is well known) and any star near it, is measured on several nights, as the asteroid passes from north to south of the star (let us say). Then, although the absolute position of the asteroid is not known, its daily motions are well determined, and the arc moved over may be used as a known distance from which the value of the screw may be determined.

The following complete list of asteroids (21 in all) discovered by the late Prof. JAMES C. WATSON, Director of the Washburn Observatory, Madison, Wis., has been compiled by the aid of the list of "Minor Planets," published by Mr. A. N. Skinner in the *American Journal of Science and Arts*, Vol. XVIII, *Dec.*, 1879. All of these asteroids, with one exception, were discovered at the Ann Arbor Observatory, Michigan. Juewa was discovered at Peking, China, where Prof. Watson was in charge of one of the Transit of Venus parties.

NUMBER.	NAME.	DATE OF DISCOVERY.
79	Eurynome	September 14, 1863.
93	Minerva	August 24, 1867.
94	Aurora	September 6, 1867.
100	Hecate	July 11, 1868.
101	Helena	August 15, 1868.
103	Hera	September 7, 1868.
104	Clymene	September 13, 1868.
105	Artemis	September 16, 1868.
106	Dione	October 10, 1868.
115	Thyra	August 6, 1871.
119	Althæa	April 3, 1872.
121	Hermione	May 12, 1872.
128	Nemesis	November 25, 1872.
132	Aethra	June 13, 1873.
133	Cyrene	August 26, 1873.
139	Juewa	October 10, 1874.
150	Nuwa	October 19, 1875.
161	Athor	April 19, 1876.
168	Sibylla	September 28, 1876.
174	Phædra	September 3, 1877.
175	Andromache	October 1, 1877.

The report of the *Telegraphic Determination of Longitudes on the East Coast of South America*, by Lieutenant Commanders F. M. GREEN, and C. H. DAVIS, and Lieutenant J. A. NORRIS, U.S. N., has been issued recently from the Hydrographic Office. This work embraces the meridians of Lisbon, Madeira, St. Vincent, Pernambuco, Bahia, Rio de Janeiro, Montevideo, Buenos Ayres and Para, and is designed to supplement the work done in 1877, under the direction of Lieutenant Commander Green, in the West Indies and Central America, by connecting important points in South America, whose longitudes have always been exceedingly uncertain, with well-known places in Europe.

Having made arrangements with the French *Bureau des Longitudes* to furnish the party with the difference of longitude between Lisbon and Paris, the work was begun in December, 1877, by connecting Lisbon, Portugal, with Funchal, Madeira, by means of an intervening station at Carcavellos. This "transmitting" station was found necessary in order to connect the submarine cables with the land lines; a direct connection endangering the safety of the cables. Partly by cables, and partly by the overland wires, the stations from Lisbon to Buenos Ayres were connected in the order named above, with the exception of a break between Pernambuco and Rio de Janeiro caused by a defect in the cable. These two stations were connected with Bahia, and Pernambuco with Para in 1879; and as the French Government had failed to communicate to the Hydrographic Office the longitude of Lisbon, it was determined to connect Lisbon with Greenwich, in order to make the chain complete. This last connection was effected by means of transmitting stations at Porthcurnow, Lands End, and Carcavellos on the coast of Portugal. The reduction of comparisons of the Lisbon and Greenwich clocks "gives the somewhat startling result that the longitude of the observatory at Lisbon, has, up to the present time, been in error more than two miles." The American determination of the difference of longitude between these two places being $9^\circ\ 11'\ 10.2''$, while that heretofore accepted has been $9^\circ\ 9'\ 2.1''$.

Of the instruments used, the Transit Instrument was of what is known as the "broken transit" pattern (the eyepiece being at one end of the horizontal axis), especially designed for this work by Mr. J. A. Rogers, and fitted to be used as both transit and zenith-telescope. It was of 2.5 in. aperture and 30 in. focal length—made by Kahler, It seems to have combined considerable steadiness with great portability, as it weighs in all but 125 lbs. In speaking of the performance of this instrument, the report says: "The results of the observations have demonstrated that the reversal of the axis is almost inevitably attended with a slight change of azimuth, and that a correction must always be introduced for flexure of the axis," and adds further on, that these effects "are probably unavoidable in portable instruments of this pattern."

In the reductions, no correction has been applied for personal equation of the observers, either in noting transits of stars, or in receiving the deflections of the galvanometer needle from the cables. After careful experiment, it was found that the correction would be quite small, and in view of the uncertainty involved in its determination, it was decided to take no account of such error, but to eliminate it, as far as possible, by placing one observer alternately east and west of the other, commencing at Lisbon. Advantage was taken of every opportunity to make latitude determinations with the zenith-telescope, and the results in both latitude and longitude show that nearly all of the stations occupied have been up to this time considerably in error.

The spectrum of Hartwig's comet has been observed by Konkoly and Backhouse, and by Young in this country. It gives four bright lines, whose wave-lengths are respectively 5609, 5492, 5169, and 4859 tenth-meters, and a faint continuous spectrum. W. C. W.

Washington, D. C., November 30, 1880.

SWIFT'S COMET.

Swift's comet is a faint object, and its distance from the sun is so great, never less than 1.102, and therefore always outside the earth's orbit, that no great changes of form are to be expected, such as we see in comets that pass near the sun. A. HALL.

To the Editor of Science:

Several interesting observations have been made by me of Swift's latest comet. The last observation was made on the evening of November 26th, at 7.20 P.M.T., being then by estimation in about A. R. 2 hours 30 minutes, north declination 53 degrees 45 minutes. It was quite a conspicuous object in the 5-inch Newtonian Re-

flector, being fully as bright on that date as at any previous observation, although its theoretical brightness is decreasing. It is a faint, diffused object, but to show that it is within the range of quite moderate telescopes, I would say that I first picked it up on the evening of November 5th, with a refractor of only two inches aperture. In my last observation two faint stars were seen shining through the comet.

The comet's position for the 10th of December will be A. R. 4 hours 40 minutes, Dec. + 44 degrees 47 minutes. On December 14th it will be about 5 degrees south of Capella. WILLIAM R. BROOKS.

Red House Observatory, Phelps, N. Y.,
November 30th, 1880.

MICROSCOPY.

Dr. Carpenter, the well-known English microscopist, occupied the attention of the Royal Microscopical Society, on the 6th instant, by describing the "Student Microscope," recently designed by Mr. George Wale, of New Jersey. The instrument in question was highly commended for its efficiency, and English opticians were advised to consider the practical improvements it suggests.

Mr. James Swift exhibited and described an improved form of *Calotte* diaphragm, consisting of a series of small circular apertures, to be applied above the achromatic condenser immediately beneath the object, and on a level with the surface of the stage.

A binocular eye-piece, by Professor E. Abbe, was described as consisting of two uncemented prisms (together forming a thick plate of glass) in the direct tube; the adjacent diagonal surfaces of the prisms being both cut at the calculated angle of 38° 5', which angle was computed to allow precisely one-half of the light to be transmitted, and to reflect the other half; the latter half fell upon a total reflecting prism, whence the rays emerged through the diagonal tube to the left eye. Another point was the mechanism by which the *diagonal* tube attached to the direct tube by a box-fitting, was moved to accommodate the width of different observer's eyes, a screw motion causing the tube, with eye-pieces above and reflecting prism below, to travel smoothly nearer to or further from the direct and stationary tube.

The application of the eye-piece to the left tube at such a distance as to compensate for the extra distance travelled by the pencil of light, and thus render the images seen by both eyes of equal magnitude.

Lastly, the application of two semi-circular caps, one over either eye-piece; in one symmetrical position of these apertures the effect produced was *pseudoscopic* vision, by another arrangement of them stereoscopic vision was obtained.

This form of binocular is said to be specially applicable to the short tubes of Continental microscopes and some of American make,

A new fluid for writing the names of objects on glass slides is sold by Mr. Browning, of London. It is more active than hydrofluoric acid, and has an immediate action on the surface of glass.

Dr. Günther, of Berlin, has made photographs of *Frustulia Saxonica.* These and a micro-photograph by Mr. S. Wells, of Boston, were compared with the photograph by Dr. Woodward, produced in 1875. The latter showed no trace of beaded resolutions, whereas both the former showed the resolutions remarkably well. Mr. Mayall asks if Dr. Woodward still maintains his opinion of the unreality of the longitudinal lines.

Mr. Crisp mentions that Professor Abbe has found great advantage in mounting diatoms in monobromide of naphthaline, by which they were rendered far more visible than when mounted on Canada balsam.

BOOKS RECEIVED.

THE NATURALIST'S DIRECTORY FOR 1880. Edited by SAMUEL E. CASSINO, 299 Washington street, Boston. May, 1880.

This useful work will be welcome in scientific circles; it contains the names, addresses, special departments of Study, of Naturalists, Chemists, Physicists, Astronomers, etc., etc., etc. It also gives a list of scientific societies, of scientific periodicals, and the titles of scientific books published in America from July 1, 1879 to October 1, 1880.

The arrangement of the names in this edition of the directory is by States, and was adopted after repeated requests, though not, as the publisher admits, without misgivings on his part as to the convenience of the list thus arranged. On this point we are glad to notice that what we consider to be an error is acknowledged, and that in future the alphabetical order will be resumed. For our purposes the directory thus arranged is almost useless, as the loss of time in searching 45 separate lists for an address, is a great drawback to the use of the work.

We are also at a loss to know on what principle the list has been constructed, as the omission of the names of well-known scientific men is quite incomprehensible; as examples we fail to notice Professor John Le Conte, of California; Professor W. H. Brewer, of Yale; Professor Jas. D. Dana, of Yale; Professor Simon Newcomb, of Washington; Col. J. J. Woodward, M. D., Washington; Professor Asaph Hall; Professor Julius E. Hilgard, Washington; Professor C. Y. Young, of Princeton; Professor C. F. Chandler, of New York City; Professor Henry Draper, of New York City; and Professor Jno. W. Draper, of Hastings-on-Hudson, or Mr. Edison. We have had no time to make a systematic search for omissions, but the above names which are household words in scientific circles do not appear.

As we find some of these names have already appeared in previous editions, the present omission would not appear to be altogether accidental.

As this directory is the only one of its kind published, we suppose these errors will not effect its sale, but we regret that a more perfect work was not produced.

Since writing the above notice, we have heard from the publishers of the Directory; they state that the arrangement of the work is acceptable to a majority of the subscribers, and that the cause of the omission of names was due to their failure to receive responses to printed circulars which were forwarded to all known scientists.

The readers of this journal must be familiar with the efforts we have made to secure a perfect register of the scientific men of the United States. Our intention in this respect was also made known by an editorial notice in the New York *Times*, and in the *Medical Record* of last week.

The *Times* pointed out the value of such a perfect list, and the little trouble it entailed on scientific men. So far the response to our appeal has been very partial. We therefore again request those who have hitherto failed to forward their names and addresses, with speciality of study, to do so at once, and if the heads of Universities and Colleges would make up lists, considerable help would be rendered.

We also suggest that those interested in scientific pursuits make up lists of scientific men in their neighborhood, and of amateurs following a particular line of scientific investigation.

As we stated lists of names will be forwarded to the Smithsonian Institution, and Messrs. Cassino and others will have the full benefit of it for future use.